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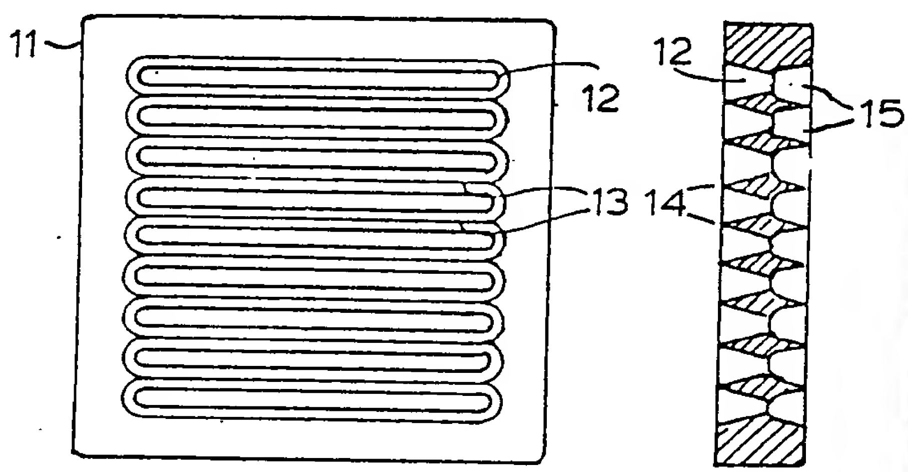
(54) Title: APPARATUS FOR MODIFYING THE COMBUSTION CHARACTERISTICS OF GASEOUS FUEL MIXTURES FOR INTERNAL COMBUSTION ENGINES

(57) Abstract

An internal combustion engine with means for increasing the turbulence of gases passing an inlet to the cylinder or cylinders, this means comprising elements which define a plurality of slots (12) for the flow and which present edges (14) which are sharp or substantially so. Preferably the slots (12) are long and of uniform width. In a preferred arrangement the slots (12) are in the shape of involute curves to a central circle. Preferably the turbulence increasing means surround the inlet valve. Such means can alternatively be placed at a manifold connection to the cylinder block.



Apparatus for modifying the combustion characteristics of gaseous fuel mixtures for internal combustion engines

This invention relates to the construction of devices for increasing the speed of combustion of the gaseous fuel mixtures used in internal combustion engines, particularly, but not exclusively, those which are obtained by the entrainment in air of a volatile liquid fuel such as gasoline.

The complete combustion of a fuel gas mixture always takes an interval of time which is appreciable in relation to the speed of operation of the engine in which it is used, and it is highly desirable to create conditions in which this period is as short as possible so that the hot combustion products are very rapidly available for producing mechanical work during the expansion stroke in the engine cylinder. The shorter the burning period, the less is the heat loss to the cylinder walls and the exhaust gas, with correspondingly significant effect on the efficiency of the engine.

It is well known that the speed of propagation of a flame through a fuel gas mixture is increased if there is turbulence therein, and it is the object of all embodiments of this invention to produce such turbulence in the form of small, high speed vortices, and in such a manner that the volumetric efficiency of the engine is not seriously reduced as a result of the pressure drop suffered by the gas in passing through the devices. A further object of introducing vortices, which can have a speed of revolution of some thousands per second, is to provide a scrubbing action on the droplets of fuel arriving from the carburation device as these possess too much inertia to follow the motion of the vortices, and are usually present in abundance as a fine mist because it is not normally possible to

cause a liquid fuel to evaporate to a true gas prior to arrival at the engine cylinder. There is, therefore, a homogenising effect which permits the use of a leaner fuel mixture than is otherwise possible. Lastly, the devices provide surfaces against which large fuel droplets are comminuted by impact.

The invention provides an internal combustion engine having a cylinder inlet with means for increasing the turbulence of gases passing the inlet, said means comprising elements which define a plurality of slots for the flow thereto and which present edges which are sharp or substantially so.

In general, according to the invention, the devices for increasing turbulence create vortex motion by constraining the inrushing gas to pass through a number of fine slits defined by bars or the like which present a sharp, or finely radiused edge, to the gas mixture. The flanks of the bars may be flat or concavely or convexly curved, as may be their downstream faces. The bars may be straight or curved in the plane perpendicular to the direction of gas motion and, in the latter case, may be in conoidal formations. The slits are preferably of constant width throughout their lengths and number and it is desirable that the bars or ribs defining them should be likewise. The slit widths may, however, be variable in embodiments in which two of the rib bearing devices are arranged to slide relatively on a mutually plane interface, the combination then serving also as an engine throttling means.

According to the invention, the devices for increasing turbulence may be installed at any position between the carburation means and the engine cylinder, but are, desirably, as close to the latter as possible in order to reduce the volume of gas which tends to become quiescent during the non-inductive strokes of the engine.

The best position in motors utilising mushroom-type poppet valves is immediately close to the upstream side of the valve seat, a central hole being provided in the device to permit the valve stem to work through it with a slight clearance. Another practical position is at the inlet manifold connection to the block.

In use, the sheet-like jets of gas issuing from the slits immediately break up into vortices revolving intermittently in contrary directions; the process may be initiated by the edge tones produced by the sharp upstream edges of the ribs in a manner frequently utilised in musical wind instruments. The resulting small scale disturbance in the gas is easily able to persist for the duration of the induction and compression strokes of the engine piston until the instant of ignition. Although the devices are primarily intended to be used in engines powered by air-entrained fuel, they may also prove of value in cases when the fuel is injected directly into the cylinders.

The invention will now be further described with reference to the accompanying drawings, in which:

Figures 1 and 1a are respectively plan and cross-section of a plate formed with slots, forming one means according to the invention for increasing turbulence of gases;

Figures 2 and 2a are respectively sectional plan and cross-sectional view of a duct with further means according to the invention for increasing turbulence in gases flowing through the duct;

Figures 2b and 2c are cross-sectional views showing respectively two further forms of means for increasing turbulence of gases;

Figure 3 is a diagram illustrating the mathematical definition of an involute curve;

Figures 4a and 4b are respectively plan and

cross-sectional view of a plate formed with involute slots, forming a further turbulence increasing means according to the invention;

Figure 5 is a cross-sectional view of the inlet arrangement of an internal combustion engine showing a turbulence increasing means in an operative position;

Figures 6 and 6a are respectively a plan and a sectional view of a duct wherein are mounted two slotted plates; and

Figures 7 and 7a are respectively views in plan and section of two plates both formed with involute slots, the combination forming a further example of means according to the invention for increasing the turbulence of gases.

Figure 1 shows a plate which is suitable for use in a duct which has been flared to a square to accommodate it. The plate 11 is provided with equally spaced slits 12 of equal widths formed by parallel ribs 13, the sides of which are tapered to merge into sharp edges 14 on the upstream side of the plate. Cross-sectional Figure 1a shows the slits entering partially circular cavities 15 which help to promote the formation of strong vortices. This artifice may be used with any of the devices herein described.

Figure 2 is a view down a circular duct 21, in which are mounted a series of concentric rings 22, held in position by at least three support bridges 23. The rings 22 are of triangular cross-section, presenting sharp edges to the inrushing gas as shown in the sectional diagram 2a. Figure 2b shows a series of three such devices (but without support bridges), closely spaced and in staggered array, the rings 22 having rounded downstream edges, a style which may be adopted in all embodiments. With the less volatile fuels, this is

useful in preventing the accumulation of large globules of fuel at the downstream edges of the rings. This last result may also be obtained by using triangular section rings of the shape shown at 24 in the sectional view of Figure 2c, which also depicts the rings mounted in a conoidal formation. A series of such conoidal arrangements may be used in staggered positions along the direction of gas flow.

Figure 3 shows a method of generating the mathematical involute to a central circle 31 by unwinding an inextensible cord 32 from a drum of the same diameter. It will be seen that the curves outside the central circle are parallel throughout their lengths. This is the only known spiral with which this result can be realised and is utilised in the construction of the devices to be described hereinafter. Other spirals could be used, but are not so effective.

Figure 4 shows a plate 41 perforated with equi-angularly spaced slits 42 of the circular involute type described. It will be seen that the widths of both slits and ribs are constant throughout their respective lengths as shown at 43 and 44. The aerodynamic conditions are therefore the same around circles of given radius and the arrangement provides the maximum possible total length of slit within the outer defining circle. Figure 4a shows further alternative rib cross-sections 45 and 46. This type of device is particularly suitable for installation in each duct of a distribution manifold where it meets the engine block of a multi-cylinder engine.

Figure 5 shows a plate 51 mounted immediately upstream of a mushroom type inlet poppet valve. In this case, the inner ends of the ribs, which are similar in plan to those shown in Figure 4, terminate in a boss 52 provided with a central hole to enable the valve stem to slide through with a slight clearance.

Figure 6 shows a pair of plates 61, similar

to those depicted in Figure 4, together with a spacing ring 62. Plates 61 are orientated so as to be out of angular alignment by one half of the angular rib pitch, the edges of the second plate then appearing directly in line with the slits of the first plate, and being thus throughout their lengths. The upstream plate is shown provided with a conical deflector 63 to direct the gas the more smoothly towards the slits. The upstream plate is shown provided with yet another possible type of rib section of arcuate form 64. When the plates are separated by a distance of between 2 to 5 times the slit width, the arrangement is found to emit a high pitched musical note, indicating the presence of strong and stable vortex formations. Resistance to gas flow is but little increased by the addition of the second ribbed plate and the arrangement is particularly satisfactory for comminuting large fuel droplets such as those arriving at the cylinder as a result of the fuel film deposited on the walls of cold manifolds and being gradually swept along same. Large fuel droplets are able to pass through the engine without becoming completely burnt and are the most significant cause of hydrocarbon pollution in the atmosphere.

Figures 7 and 7a give views of a throttling device consisting of two plates 71 pierced with slots 72 of the circle involute type previously described. Relative rotation of the plates on a common flat face about a common axis 73 results in the appearance of slits 74, all of which are the same width throughout their lengths unless the device has been deliberately designed to ensure that the slits are not opened simultaneously, which may sometimes be of advantage, particularly when it is desirable to leave one or more of the slits permanently slightly open when the engine is idling. The slots 72 are shown as having parallel

sides, but both upstream and downstream of the necessary common flat face the slots may be of any of the forms already described. The throttle may also be used in conjunction with correspondingly slotted plates as indicated in Figure 6. This throttle is particularly suitable for arrangements in which it is desired to provide a separate throttle for each cylinder of a multi-cylinder engine. They may be installed where the induction manifold meets the cylinder block, selective operation being possible with a suitable arrangement of linkwork or cams, which may, if desired, shut down one or more of the cylinders completely when full engine power is not needed.

When a fuel charge is compressed, the heating effect induced thereby results in the formation of a great array of chemical products prior to ignition and some of them, notably peroxides, do not always burn smoothly, being prone to detonate and cause damage to the engine. When the devices described are used, they lead to a more even dispersion of the sensitive chemicals which, in combination with the fact the rapidity of combustion enables the ignition to be effected somewhat later than is normally the case, reduces the probability of the occurrence of detonation. Therefore, it will be possible to reduce the knock rating of the fuel, with consequent reduction in the amount of anti-detonation additives, the commonly used ones now being known to be physiologically dangerous.

It will be understood that various features of the different embodiments can be combined in different ways. Thus the rib sections of one can be used with another, when circumstances require.

Among possible modifications, there may be two or more assemblies as shown in Figure 2c closely spaced with the elements in staggered relation.

Claims

1. An internal combustion engine having a cylinder inlet with means for increasing the turbulence of gases passing the inlet, said means comprising elements which define a plurality of slots for the flow thereto and which present edges which are sharp or substantially so.

2. An engine as claimed in Claim 1, wherein the slots are of substantially uniform width.

3. An engine as claimed in Claim 1 or Claim 2, wherein the elements do not divert the flow except as required to pass through the slots.

4. An engine as claimed in any of Claims 1 to 3, wherein the elements define slots which are of substantially semi-circular section on the downstream side with each element terminating in a sharp edge.

5. An engine as claimed in any of Claims 1 to 3, wherein the elements have rounded downstream edges.

6. An engine as claimed in any of Claims 1 to 3, wherein the elements have sharp downstream edges, with the cross-section of diamond-shape or formed by two convex arcs.

7. An engine as claimed in any of Claims 1 to 3, wherein the elements are of generally triangular section and are flat on the downstream side.

8. An engine as claimed in any of Claims 1 to 3, wherein the elements are of triangular section and with one apex presented to the flow and another forming the downstream edge.

9. An engine as claimed in any of Claims 1 to 8, wherein the slots are straight and parallel.

10. An engine as claimed in any of Claims 1 to 8, wherein the slots are circular and concentric.

11. An engine according to any of Claims 1 to 8, wherein the slots are spiral.

12. An engine as claimed in Claim 11, wherein the slots are in the shape of involute curves to a central circle.

13. An engine as claimed in either of Claims 11 or 12, wherein the slots are formed in a disc and extend uninterrupted from a central area to adjacent the periphery of the disc.

14. An engine as claimed in any of Claims 1 to 13, wherein there are at least two generally similar sets of elements in series in staggered relation.

15. An engine as claimed in any of Claims 1 to 8, wherein there is an assembly consisting of a plurality of generally similar sets of elements of decreasing diameter arranged on a conoid envelope.

16. An engine as claimed in Claim 15, wherein there are at least two such assemblies arranged close together with the elements of the respective assemblies in staggered relation.

17. An engine as claimed in Claim 14 as dependent on Claim 11 or Claim 12, wherein the sets of elements are formed as a pair of plates, and the plates are in contact and relatively movable to form a throttle.

18. An engine as claimed in any of the preceding claims, wherein said turbulence-increasing means is placed in a duct leading to the inlet and immediately upstream thereof.

19. An engine as claimed in Claim 18, the inlet being poppet valve controlled with the stem passing with clearance through a centre opening in the turbulence-increasing means.

20. An engine as claimed in any of Claims 1 to 17, the engine having a cylinder block defining said inlet and a duct leading from a manifold connection to the inlet, the turbulence-increasing means being located at the manifold connection.

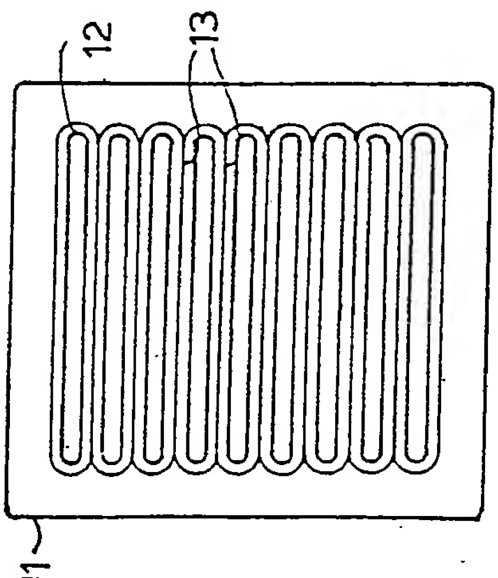


Fig.1

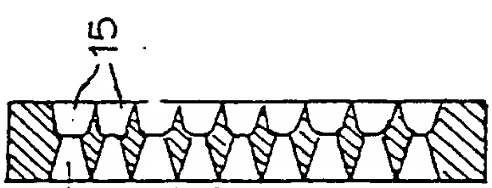


Fig.1a

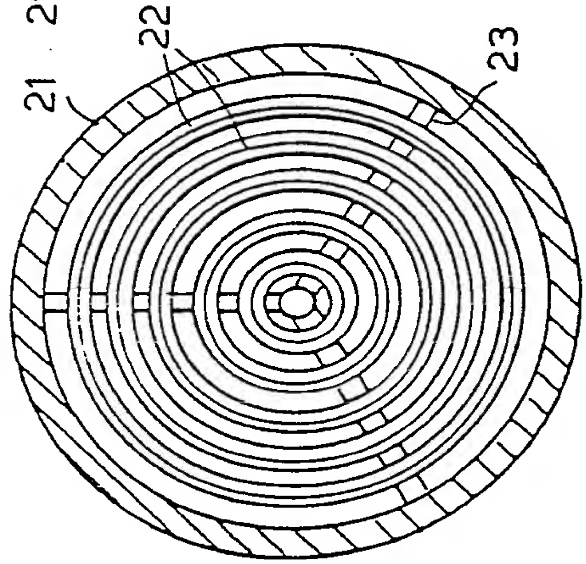


Fig.2

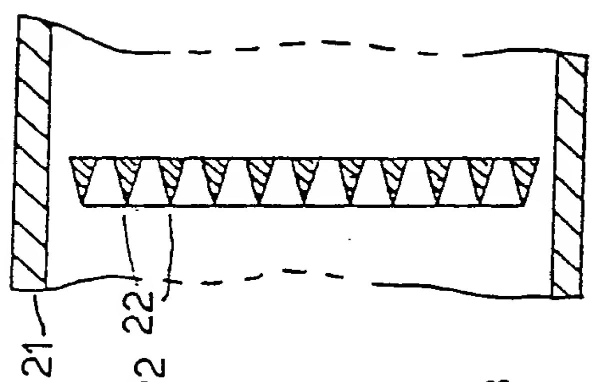


Fig.2a

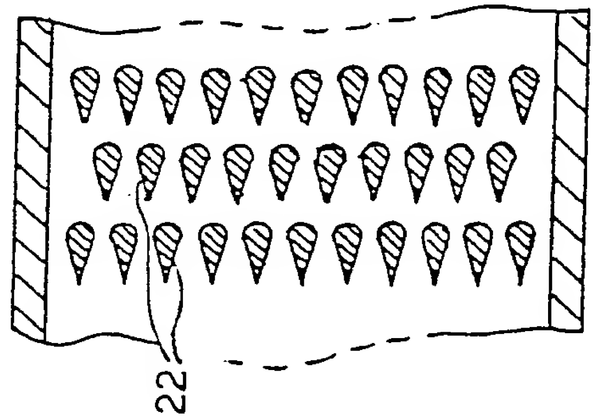


Fig.2b

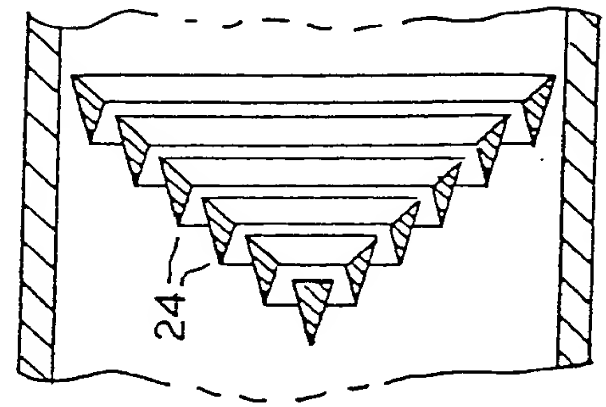


Fig.2c

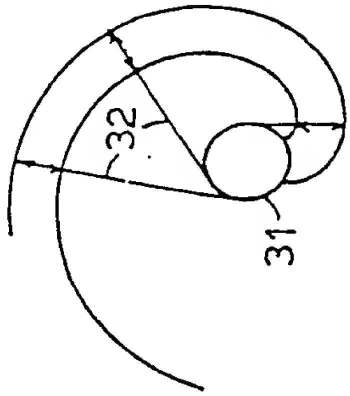


Fig. 3

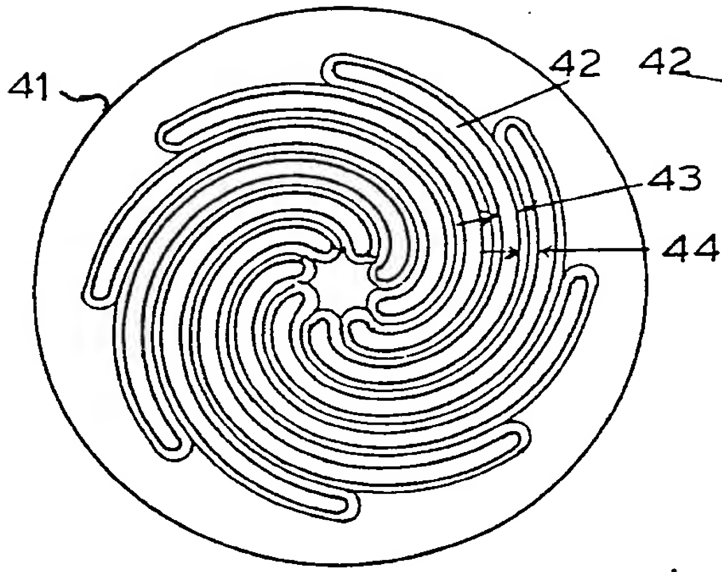


Fig.4

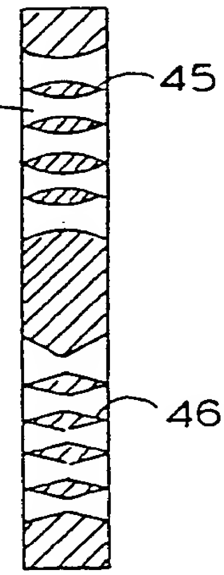


Fig.4a

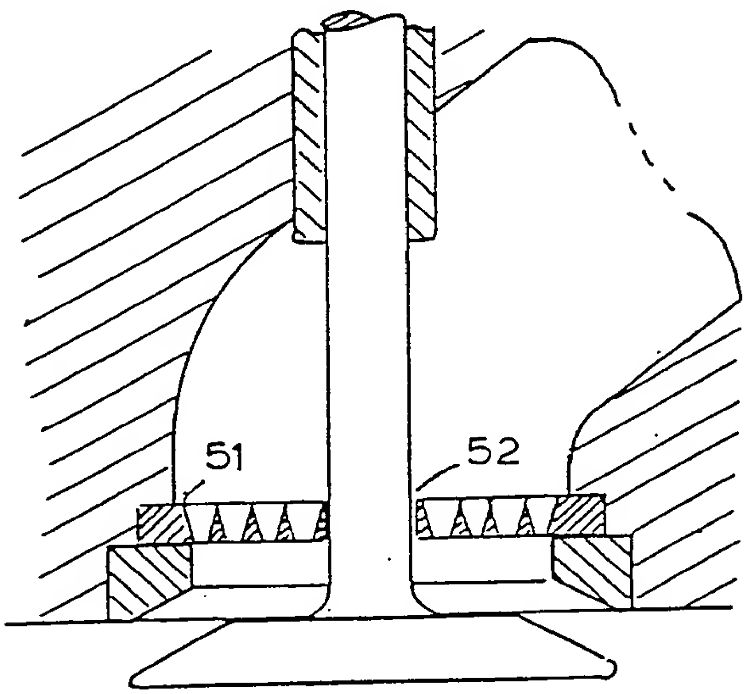


Fig.5

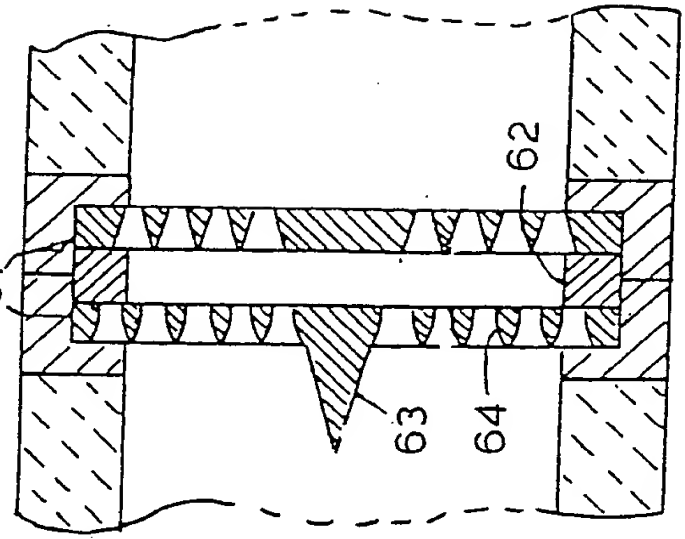


Fig.6a

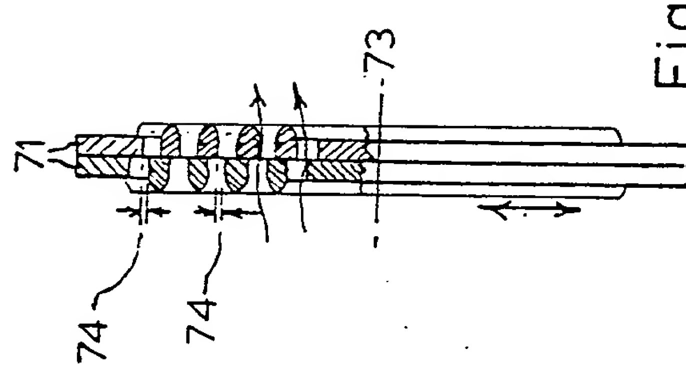


Fig. 7a

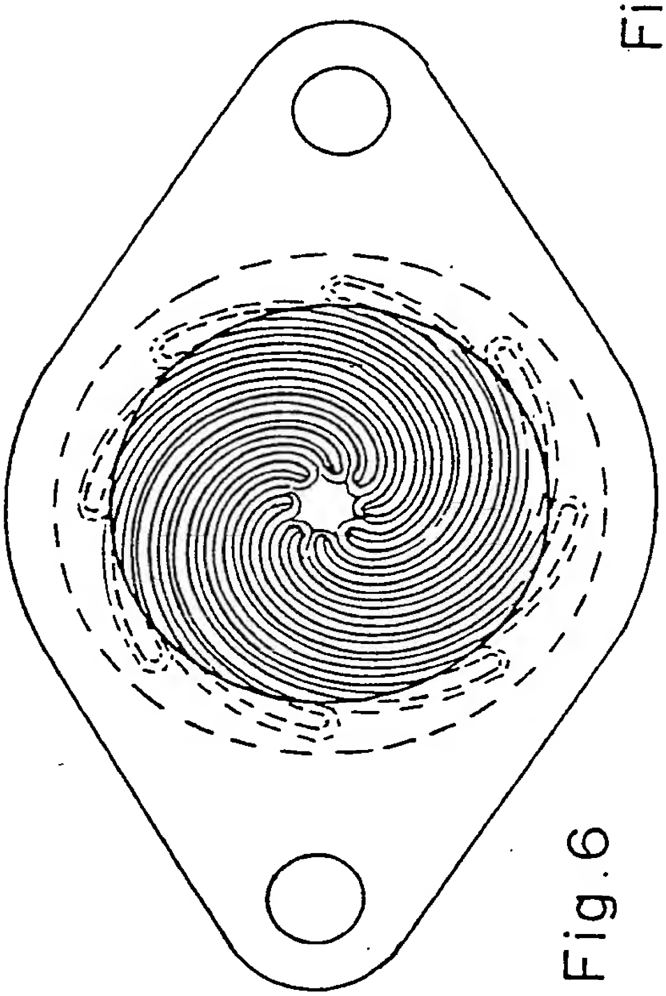


Fig.6

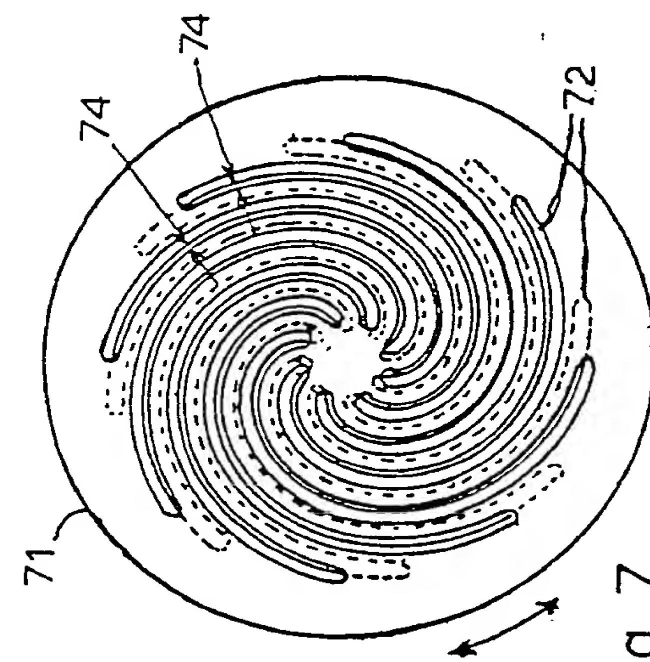


Fig.7

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 81/00241

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC^3: F 02 M 29/04

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
IPC^3	F 02 M

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate of the relevant passages [17]	Relevant to Claim No. [18]
X	DE, C, 567953 (OCKELMANN) 12 January 1933 see page 1, line 58 to page 2, line 2; page 2, lines 43-63 --	1,2,3,9,10, 11,12,13
	CH, A, 205630 (VAN CANEGHEM) 16 September 1939 see page 3, lines 9-84; page 4, lines 4-12 --	1,2,3,7,9, 10,15,16,17
	FR, A, 628283 (LUYCKX) 21 October 1927 see page 2, lines 18-28 --	1,2,3,6,9, 16
	US, A, 2857898 (COHN) 28 October 1958 see column 1, lines 15-19; column 5, lines 3-22 --	1,2,3,10
	US, A, 1503371 (MEYER) 29 July 1924 see page 1, lines 12-22 and 76-94 --	1,2,3,9
A	FR, A, 769660 (ALBERTINI) 31 August 1934 see page 2, lines 4-13 --	1,6,7
		./.

* Special categories of cited documents: [15]

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
22nd January 1982	14th February 1982
International Searching Authority [1]	Signature of Authorized Officer [20]
EUROPEAN PATENT OFFICE	G.L.M. Kruydenberg

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No [18]
A	US, A, 1551634 (BENNETT) 1 September 1925 see page 1, lines 63-105 --	1,17
A	GB, A, 1274822 (NISSAN) 17 May 1972 see page 2, lines 57-72 ------	1,18,19